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(54) **Panel for automotive vehicles**

(57) A metal panel 1 is reinforced by bonding to one side thereof a strip of material 5 that foams to expand and sets upon heating to a predetermined temperature. The strip of material 5 is covered with a second sheet material 2 that is initially pliable and that deforms slightly under heat and pressure. This sheet material 2 is also bonded to the panel around the strip material 5 so that when the panel is heated the strip material expands to deform the sheet material. After heating, the sheet material 2 and strip material 5 thus formed harden into a structural rib for increasing the structural integrity of the panel.

FIG.2B

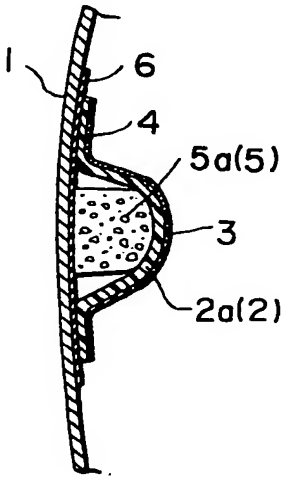

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FIG.1A (PRIOR ART)

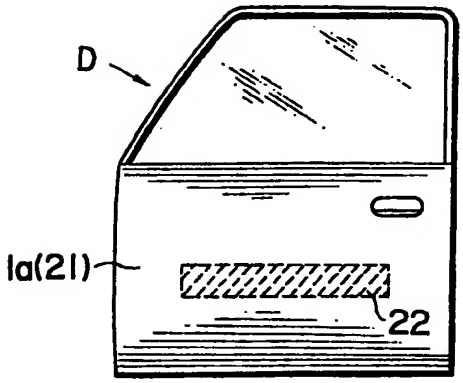


FIG.1B (PRIOR ART)

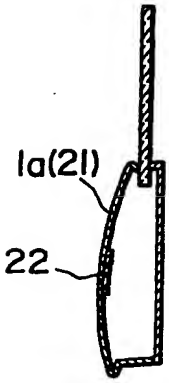


FIG.1C (PRIOR ART)

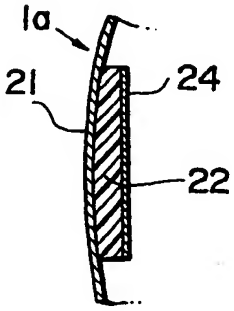


FIG.2A

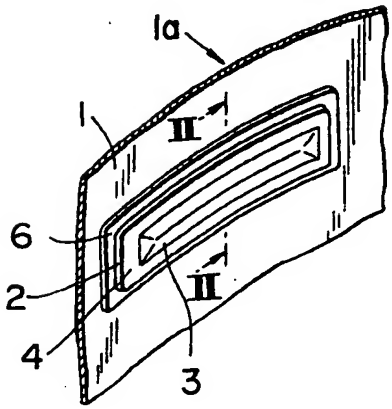


FIG.2B

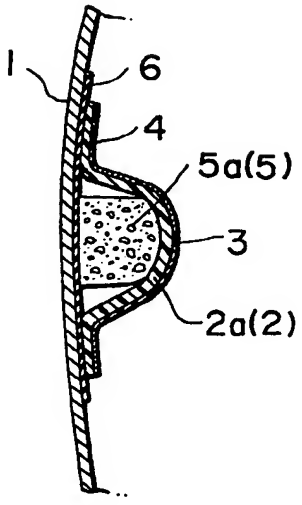


FIG. 3

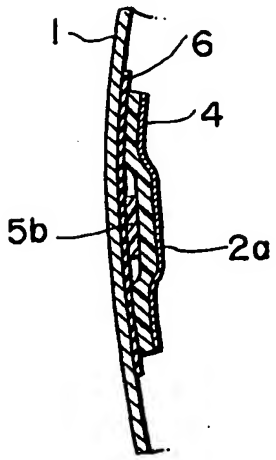


FIG. 4A

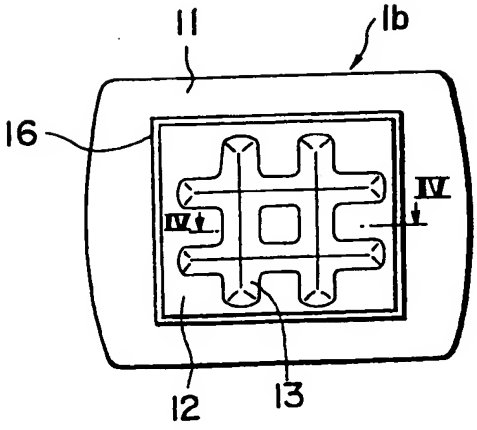
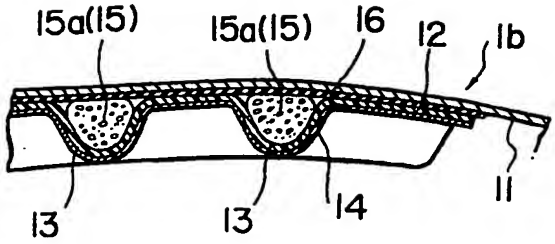


FIG. 4B



SPECIFICATION

Panel for automobiles

This invention relates to a panel for use in an automotive vehicle as, for example, a door panel or a roof panel, and to a method of making it.

In a conventional door for an automotive vehicle, a reinforced member of thermosetting resin is usually bonded to the inner side of an outer metal panel of the door to improve the strength and rigidity thereof. Figures 1A, 1B, and 1C of the accompanying drawings show such a door panel. An outer panel 1a of a door D comprises a metal panel 21 on one surface of which a reinforcing member 22 of thermosetting resin is bonded. A glass fibre woven cloth reinforcing member 24 is attached to the thermosetting resin reinforcing member 22 as is shown in Figure 1C. The thermosetting resin reinforcing member 22 is formed in a desired shape by applying heat thereto when the reinforcing member is secured to the metal panel 21.

In another previously proposed door, a thermosetting resin reinforcing member is first formed to the shape of the subject panel, and thereafter is bonded to the panel by an adhesive material.

In such previously proposed panels for automobiles, even if the starting material for the reinforcing member 22 has good strength and rigidity, the reinforcing member must be reasonably thick in order to obtain a desired strength. Thus, the quantity of the starting material to be used and the production cost and the weight of the door utilizing such a reinforcing material increase. In addition, when the reinforcing member made of a thermosetting resin is formed into a desired shape before it is bonded with adhesive to the door panel, it is difficult in practice to form the reinforcing member precisely in the shape corresponding to that of the door panel.

According to the present invention, an automobile panel includes a sheet-like main reinforcing member and a wave-like or bead-like projection formed thereon which functions as a rib of the panel. The panel is made of a metal, for example, a steel. The main reinforcing member may be made of a thermosetting resin. If the panel is steel, it is preferable that a rust-proofing film be provided on the portion of the panel to be reinforced. Also, a sheet-like auxiliary reinforcing member is preferably bonded to the main reinforcing member in a multi-layer fashion. Such an auxiliary reinforcing member can be made of glass fibre, carbon fibre, polyester woven cloth, polypropylene woven cloth, kraft paper or the like. According to the present invention, also, a method for making such a panel for an automobile is provided.

It is an object of the present invention to provide a panel for an automotive vehicle having improved strength and rigidity.

A further object of the present invention is to provide a panel for an automobile in which a thinner sheet metal may be used.

Still another object of the present invention is to provide a method for making such a panel for an automobile.

Two forms of panel constructed in accordance with the present invention, and a method of making such panels, will now be described by way of example only with reference to Figures 2 to 4 of the accompanying drawings in which:

Figure 1A is an elevation of a door having a conventional panel for an automobile;

Figure 1B shows a vertical section through the door shown in Figure 1A with some parts omitted in the interests of clarity;

Figure 1C is a sectional view showing a portion of the door shown in Figure 1B to a larger scale than Figure 1B;

Figure 2A is a fragmentary perspective view showing part of a first form of panel according to the invention, for an outer panel of an automobile door;

Figure 2B is a sectional view taken along the line II-II in Figure 2A;

Figure 3 is a sectional view illustrating a method of making a panel for an automotive vehicle;

Figure 4A is a view showing part of the back portion of a roof panel for an automobile, the second form of panel according to the present invention; and

Figure 4B is a sectional view taken along the line IV-IV in Figure 4A.

Figures 2A and 2B of the drawings show a first form of panel according to the present invention. An outer panel 1a of an automobile door comprises a panel member 1. A sheet-like member or film 6 made of a water-proof rubber is attached to a portion of the panel member 1 to be reinforced, to obtain an anti-corrosive or rust-proof condition on a desired area of the panel member 1. A sheet-like member 2 is fixedly attached to the film 6. An auxiliary reinforcing member 4 is additionally bonded to the main reinforcing member 2. The auxiliary reinforcing member 4 may be made of a woven glass fibre cloth. The main reinforcing member 2 may be made of a thermosetting resin such as an epoxy resin. The centre portion of the main reinforcing member 2 is designed to protrude in its longitudinal direction to form a bead-like or wave-like projection 3 which has preferably a hat-like cross-section.

A core 5 made of a foamed resin such as a foamed polyethylene is placed within the wave-like projection 3 of the main reinforcing member 2. It is preferable that the core 5 be sealed within the main reinforcing member 2. The core 5 initially comprises compressed, non-foam material 5*a* that foams to expand, as shown in Figure 2B, when heated sufficiently. The reinforcing material 2*a* is initially pliable, yet resistant to permanent tensile deformation, during the heating process so that the core material 5*a* may easily expand, to form the wave-like projection 3. As shown in Figure 2A, the reinforcing member 2 and the auxiliary reinforcing member 4 are preferably bonded to the panel 1, or to the film 6, to totally surround and enclose the core material 5*a* so that the panel is reinforced against bending in two mutually perpendicular directions, as opposed to only one direction, as would be the case if the ends of the wave-like projection 3 were left open. Thereafter, the reinforcing members 2 and 4 are hardened so that the wave-like projection 3 of the main

reinforcing member 2 functions as a rib of the panel member 1.

Those skilled in the art will readily appreciate that as the core material 5 expands, it produces a tensile force in the rounded or wave-like projection 3 which acts through the portions of the main and auxiliary reinforcing members 2 and 4 that are bonded to the panel 1 to impart a bending stress to the panel. This bending stress increases the structural rigidity of the panel 1 without the addition of an excessive amount of weight thereto.

A method of making such a door panel for an automobile will now be described:

First, the water-proof rubber film 6 is attached to a portion of the panel material 1 to be reinforced. As shown in Figure 3, a strip-like starting material 5*b* which can be foamed when heated is bonded to the film 6. Also, the auxiliary reinforcing glass fibre woven cloth member 4 is attached to the film 6 to cover the strip-like starting material 5b. The sheet-shaped starting material 2*a* for the thermosetting resin reinforcing member 2 is bonded to the auxiliary reinforcing member 4 to form a multi-layer structure. The starting material 2*a* is still pliable and adhesive at room temperature. One good example of the reinforcing starting material 2*a* is a sheet-like epoxy resin that is not yet hardened.

In order that the strip-like starting material 5*b* be sealed in by the reinforcing starting material 2*a*, the periphery or edge of the reinforcing starting material 2*a* is bonded with the auxiliary reinforcing member 4 to the panel member 1 under pressure so that they can be perfectly bonded to each other. Thereafter, the panel member 1 is heated at a temperature of 120°C to 180°C, for example, within a coating dry furnace. During the heating step, the strip-like starting material 2*a* is softened, and the reinforcing starting material 5*b* begins to foam. The completely foamed resin 5*a*, as shown in Figure 2B, has approximately ten times the volume of the strip-like starting material 5*b*. As a result, the reinforcing starting material 2*a* is pressed outwardly or expanded by the foaming of the starting material 5*b* so that a wave-like projection or projections are formed in the longitudinal direction of the reinforcing starting material. When heated to its thermosetting temperature, the sheet-like starting material 2*a* is hardened as it is. Consequently, improved strength and rigidity of the panel member 1 is obtained by the combination of the main and auxiliary reinforcing members 2 and 4. The wave-like projection 3 of the main reinforcing member 2 functions as a rib of the panel member 1 to improve its rigidity and strength.

Referring now to Figures 4A and 4B, a second form of panel is in the form of an automobile roof panel 1*b*, which has a larger surface area than the door outer panel 1*a*. Therefore, another type or pattern of wave-like projection 13 is formed on the roof panel 1*b* to increase its strength and rigidity. For example, a lattice-like projection 13 is preferred. Such a roof panel 1*b* may be formed with a wave-like projection 13 in substantially the same manner as the first form of panel.

Also, the roof panel 1*b* with the lattice-shaped pattern wave-like projection 13 may be produced by other methods. For example, a lattice-shaped core 15 of the foamed resin 15*a* may be bonded on the water-proof rubber film 16 which is fixed on a portion of the panel member 11 to be reinforced. A reinforcing starting material 12*a* which is not yet hardened is then attached to the film 16 and the core 15 to cover the core. Thereafter, the panel member 11 is heated to and maintained at a predetermined temperature. During the heating period, the reinforcing starting material 12*a* hardens to become the main reinforcing member 12 having the wave-like projection 13. Therefore, the wave-like projection 13 is prevented from deforming during the thermosetting period of the starting material 12*a*. As in the first form of panel, the reinforcing member 12 and the auxiliary reinforcing member 14 are preferably bonded to the panel 11 or to the film 16 to totally surround and enclose the core material 15. The ends of the wave-like projection 13 may instead be open so that it is not sealed.

This invention may be practised or embodied in still other ways without departing from the spirit or essential character thereof. For instance, while in the panels described above with reference to the drawings the starting material 2*a* or 12*a* of the reinforcing member 2 or 12 is an epoxy resin, the present invention is not limited to the use of such a resin. The starting material 2*a* or 12*a* may be made of any resin including a melamine resin, phenol resin or urea resin if it is resilient and adhesive at room temperature and can be hardened during a coating bake step of the vehicle body preferably at a predetermined temperature of between 120°C and 180°C. The auxiliary reinforcing member 4 or 14 can be made not only of glass fibre woven cloth but also a glass fibre, carbon fibre, polyester woven cloth, polypropyrene woven cloth, kraft paper or the like. While in the illustrated forms of panel the auxiliary reinforcing member 4 or 14 is attached to the outer surface of the main reinforcing member 2 or 12, it can instead be attached to the inner surface thereof or to both surfaces thereof.

The core 5 or 15 may be made not of the foamed resin 5*a* or 15*a* but of any material that has the desired thermal stability at a coating bake temperature of 120°C to 180°C and is light in weight.

The starting material 5*b* can be not a foaming polyethylene sheet but any material than can be foamed prior to the thermosetting of the starting reinforcing material 2*a* during a coating bake period and have a desired volume expansion coefficient, such as a foaming epoxy resin. Also, the starting material 5*b* may be foamed to become a softened resin such as a foamed polyethylene sheet instead of a hardened foamed resin.

The foamed resin 15*a* in the second form of panel described above may be a foamed resin having separate bulbs therein. In addition, the wave-like projection 3 or 13 can be formed in any desired shape, and not only in a straight line or lattice.

The film 6 or 16 can be of any material that has waterproofing and rust-proofing characteristics with respect to the panel 1 or 11 and a thermal stability at the coating bake temperature of 120°C to 180°C, and can be bonded to both the panel 1 or 11 and the main

reinforcing member 2 or 12. For example, the film 6 or 16 can be a paint coated on the panel for the purpose of rust-proofing.

In addition, a method of producing a panel according to the present invention is not limited to the illustrated embodiments. For instance, paint may have been previously coated on the panel 1 or 11 and dried naturally. The starting material for the reinforcement and the starting material to be foamed may then be combined. The starting material to be foamed is heated at a coating bake stage to be foamed, for example, within a coating dry furnace. As a result, it deforms the reinforcing material which is already softened by the heat so that a wave-like projection may be formed. When the reinforcing material is further heated, it hardens, and at the same time, the paint coating between the panel and the foamed resin and between the panel and the reinforcing material is completely dried.

If a stainless steel or aluminium panel is used, which needs no rust-proofing, the reinforcement can be directly bonded to the panel without coating.

According to the present invention, a wave-shaped projection of a main reinforcing member can function as a rib of a panel for an automobile to increase remarkably the strength and rigidity thereof whereby the reinforcing member can be thin so that the quantity of the reinforcing starting material is small in volume and the production cost thereof decreased.

A reinforcing material which is resilient and adhesive at room temperature is bonded to the panel. Therefore, very good contact between the reinforcing member and the panel can be easily achieved.

As the starting material is foamed for the purpose of forming a wave-like projection before the main reinforcing material is hardened, a desired type or pattern of wave-like projection or projections can be certainly and easily formed. Also, if they are heated during a coating bake period, then production can be simplified.

The present invention can be applied not only to a door panel or roof panel for an automotive vehicle, but also to front and rear fenders therefor, and to other metal parts, for the purpose of reinforcing them.

CLAIMS

1. A panel assembly for an automotive vehicle, comprising: a metal panel; a main reinforcing member bonded to the panel, the said main reinforcing member being made of a thermosetting resin; an auxiliary reinforcing member attached to the main reinforcing member; and a wave-like projection formed on the main reinforcing member in such a manner that the projection can function as a rib of the panel.

2. A panel assembly as claimed in claim 1, wherein the main and auxiliary reinforcing members are combined in a laminar fashion.

3. A panel assembly as claimed in claim 1 or claim 2, further comprising a film bonded to the panel for the purpose of rust-proofing the panel, the [illegible] being bonded to the film

4. A panel assembly as claimed in any one of claims 1 to 3, further comprising a core placed in the wave-like projection so that the main reinforcing member can be prevented from deforming when it is heated during a coating bake period of the panel.

5. A panel assembly as claimed in claim 4, wherein the core is made of a light foamed resin.

6. A panel construction for an automotive vehicle, the panel being made of a metal, comprising: a sheet-like main reinforcing member made of a thermosetting resin, the main reinforcing member being bonded to a portion of the panel to be reinforced; and a wave-like projection formed integrally on the main reinforcing member in such a manner that the projection can function as a rib of the panel.

7. A panel construction as claimed in claim 6, further comprising a core made of a foamed resin, the core being fixed to the panel, the main reinforcing member having an edge portion bonded to the panel in such a manner that the main reinforcing member covers the whole of the core.

8. A panel construction as claimed in claim 6 or claim 7, wherein the portion of the panel to be reinforced where the core and the main reinforcing member are positioned is in a rust-proof condition.

9. A panel construction as claimed in any one of claims 6 to 8, further comprising a sheet-like auxiliary reinforcing member provided on the main reinforcing member in a multi-layer fashion.

10. A method of making a panel for an automotive vehicle, comprising the steps of: bonding a film for the purpose of rust-proofing to a portion of the panel which should be reinforced; bonding to the film a strip-like starting material made of a resin which can be foamed at a predetermined high temperature; bonding a sheet-like starting material, the said sheet-like material being made of a resin which is resilient and adhesive at room temperature and can be hardened at a predetermined temperature higher than the foaming temperature of the strip-like starting material, to the strip-like starting material in such a manner that the sheet-like starting material covers the strip-like material; heating the panel, the sheet-like starting material, the strip-like starting material and the film; foaming thereby the strip-like starting material to form a core of a foamed resin as well as a wave-like projection of the sheet-like starting material on the core; and hardening the sheet-like starting material by further heating thereof to form a main reinforcing member having the wave-like projection so that the projection can function as a rib of the panel.

11. A method as claimed in claim 10, further comprising the step of providing an auxiliary reinforcing member of a sheet-shape of glass-fibre on the main reinforcing member.

12. A method for making a panel for an automotive vehicle, comprising the steps of: bonding a film for the purpose of rust-proofing onto a portion of the panel which is required to be reinforced; bonding onto the film a core made of a foamed resin and a sheet-like starting material which is resilient and adhesive at room temperature and can be hardened at a predetermined high temperature, in such a

manner that the sheet-like starting material covers the core so that a wave-like projection is formed on the core; heating the sheet-like starting material; and hardening the sheet-like starting material and the wave-like projection thereof so that the projection can function as a rib of the panel.

13. A method as claimed in claim 12, further comprising the step of providing an auxiliary reinforcing member made of glass-fibre on the main reinforcing member in a multilayer condition.

14. A panel substantially as hereinbefore described with reference to, and as shown in, Figures 2A and 2B, or Figures 4A and 4B of the accompanying drawings.

15. A method substantially as hereinbefore described with reference to the accompanying drawings.

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